Modelling the Performance of Irish Credit Unions, 2002 to 2010.

J. Colin Glass, Ulster Business School, University of Ulster, Cromore Road, Coleraine, BT52 1SA, UK.

Corresponding Author: Donal G. McKillop, Queen's University Management School, Queen's University Belfast, Riddel Hall, 185 Stranmillis Road, Belfast, BT95EE, UK
T: +44 (0)2890974852; F +44 (0) 2890974201; E-mail dg.mckillop@qub.ac.uk

Barry Quinn, Queen's University Management School, Queen's University Belfast, Riddel Hall, 185 Stranmillis Road, Belfast, BT95EE, UK

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Abstract

This study undertakes a modeling based performance assessment of all Irish credit unions between 2002 and 2010, a particularly turbulent period in their history. The analysis explicitly addresses the current challenges faced by credit unions in that the modeling approach used rewards credit unions for reducing undesirable outputs (impaired loans and investments) as well as for increasing desirable outputs (loans, earning assets and members' funds) and decreasing inputs (labour expenditure, capital expenditure and fund expenses). The main findings are: credit unions are subject to increasing returns to scale; technical regression occurred in the years after 2007; there is significant scope for an improvement in efficiency through expansion of desirable outputs and contraction of undesirable outputs and inputs; and that larger credit unions, that are better capitalised and pay a higher dividend to members are more efficient than their smaller, less capitalised, and lower dividend paying counterparts.

Keywords: Credit unions, efficiency, impaired loans and investments

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1. Introduction

Credit unions are not-for-profit, member-owned, voluntary, self-help, democratic, cooperative financial institutions that provide financial services to their members. In Ireland the credit union movement has one of the highest penetration levels in the world with approximately 65 percent of the population a member of a credit union. In 2010 there were 404 Irish credit unions with assets of €14.1 billion serving approximately 3 million members which equates to a population penetration level of 66 percent which suggests that credit unions are present in almost all communities in Ireland. Indeed, credit union penetration in Ireland is higher than in any other country in the world. The World Council of credit unions (WOCCU) estimated that in 2011 there were 51,013 credit unions in 100 countries, with 196.5 million members holding $1.56 trillion in assets.

From the mid-1990s to 2007, Irish banks significantly expanded lending to the commercial and residential property sector. The collapse in prices and activity in both these markets post-2007 coupled with the downturn in general economic activity necessitated a major bailout for all Irish banks which now rely substantially on liquidity support from the ECB and the Irish Central Bank (McQuinn and Woods, 2012). The collapse of the banking sector, stagnating property markets and fiscal austerity has put extreme pressure on Irish households. Personal consumer expenditure fell by 1.1% in 2008, 6.9% in 2009, 0.8% in 2010, 2.5% in 2011 and is projected to fall by 2.0% in 2012 while the unemployment rate increased to 6.3% in 2008, 11.8% in 2009, 13.6% in 2010, 14.4% in 2011 and is forecast to be 14.0% in 2012 (IBEC, January 2012).

In that credit unions through legislation have not been permitted to engage in mortgage lending they have been protected from the worst excesses of the Irish financial crisis. Credit unions operate predominantly in the market for shorter term loans (less than 5 years) to Irish households. The banks cover this market and in addition the markets for long term loans to Irish households, loans to non-residents, and loans to the non-financial Irish private sector (outstanding value of €98 billion in September 2011). That said, post 2007, adverse economic conditions have still impacted on Irish credit unions. In 2008 loans written off were €41.85m, but rose to €87.95m in 2009 and €107.44m in 2010 (1.7% of gross loans). It is also the case that the decline in the fortunes of Irish credit unions is not wholly related to economic factors. Other contributory factors include the business decisions of some credit unions and the deficiencies in the statutory regulatory framework, (Forsey, 2010).

Concern over the current position faced by credit unions as well as concerns about their future development was such that the Irish Government established a Commission in May 2011 to review the structural and regulatory landscape within which credit unions operate. The Commission's Report was published in March 2012 and identified a number of areas where reform is required ranging from the introduction of a new legislative framework to significant sectoral restructuring. With respect to the latter, the Commission argued that restructuring would involve moving from a situation where 408 credit unions operate and act independently, to one where there is consolidation through amalgamations and the development of close networks and shared services. They viewed restructuring as a way of addressing the current weaknesses in the sector as well as a business strategy for credit unions that want to achieve the scale necessary to move to a more efficient and sophisticated business model. Critical in the proposed plan is the identification of stronger credit unions which would anchor restructuring with other (weaker) participating credit unions.

The current empirical study which investigates the relative performance of Irish credit unions over the period 2002 to 2010 provides evidence in support of sectoral restructuring. Furthermore, the analysis explicitly addresses the current challenges faced by credit unions in that the modelling approach used rewards credit unions for reducing undesirable outputs (impaired loans and investments) as well as for increasing desirable outputs and decreasing inputs. A pioneering application of this modelling to banking is provided in Park and Weber (2006), which uses the directional distance function approach of Chung et al (1997) for handling good and bad outputs. The Park and Weber (2006) study employed data envelopment analysis (DEA) to empirically model the production technology and to measure each bank's efficiency relative to the empirically-constructed best practice frontier. This type of nonparametric analysis can be readily extended by adding a parametric second stage which employs a regression technique to infer how various producer-specific factors influence the relative efficiency of the financial institutions involved. As an alternative to the preceding two-stage method for investigating efficiency determinants, the current study uses an application of the innovative Cuesta et al (2009) parametric approach to efficiency measurement.

The only previous investigation of Irish credit union performance is that of Glass et al. (2010) which is based on 2006 data and investigates performance determinants and the opportunity cost of regulatory compliance using a non-parametric methodology. A key finding of this analysis was that 68 percent of Irish credit unions do not incur an extra opportunity cost in meeting regulatory guidance on bad debt. The analysis also revealed that 93 percent of Irish credit unions operate at various levels of inefficiency and while best-practice and inefficient credit unions had many similar characteristics those identified as best-practice had much lower levels of bad debt and tended to be designated as industrial/associational credit unions.

The present study yields a rich set of results. The analysis highlights that (i) Irish credit unions could improve productive performance by expanding desirable outputs while simultaneously contracting impaired loans and investments and inputs; (ii) that Irish credit unions are subject to increasing returns to scale; (iii) that larger credit unions, that are better capitalised and pay a higher dividend to members are more efficient than their smaller, less capitalised, and lower dividend paying counterparts; and (iv) that credit union efficiency levels have deteriorated significantly post 2007. These findings point to restructuring being necessary and additionally provide evidence that restructuring may be best achieved if it is anchored by those credit unions that pay better dividends, are larger and are better capitalised.

The remainder of the paper is structured as follows. In Section 2 we overview the efficiency literature on credit unions. The methodology is outlined in Section 3 and the data described in Section 4. Empirical results are presented and discussed in Section 5 with a summary and some concluding comments presented in Section 6.

2. Efficiency Studies

There is a large empirical literature on the measurement of cost structure and efficiency in the financial services industry (see Hughes and Mester, 2010). In contrasting the volume of work on banks with that on mutual financial services organizations, Worthington (2010, p.39-40) states:

"In the main, the substantive part of this research has focused on medium-to-large deposit-taking institutions ..... [however], the need to understand issues of efficiency and productivity is no less pronounced in financial mutuals with the important role this information can provide in assessing the impact of regulation and yielding insights into the process of organisational and structural change characteristic of recent decades."

Early studies in this area use either ratio analysis or simple production and cost functions to assess performance. For the US see for example Taylor (1972 and 1977), Wolken and Navratil (1980), Kohers and Mullis (1987 and 1988). For Australia, see Crapp (1983), Brown and O'Connor (1995) and more recently Esho (2000). For Canada, Murray and White (1983) and Kim (1986). For the UK, see McKillop et al. (1995) and for New Zealand Sibbald and McAlevey (2003). The general picture that emerges from these early studies is that credit union movements in most countries are characterised by increasing returns to scale. This provides a justification for growth strategies pursued by credit unions (either internally generated or via merger and acquisition) and for regulation permitting expansion of the common bond.

More recently credit union performance (efficiency) has been assessed employing frontier efficiency measurement based upon parametric and non-parametric techniques. The empirical measurement of economic efficiency centres on determining the extent of either allocative efficiency (the ability of an organization to use its inputs in optimal proportions, given their prices and the production technology) or technical efficiency (the ability to use resources in the most technologically efficient manner) or both in a given organization or industry.

For the US, Fried et al. (1993) evaluate performance using a Free Disposal Hull (FDH) analysis, which is a generalisation of DEA. The analysis highlights that there are a large number of best-practice credit unions with influences on efficiency traced to locational and institutional characteristics. Fried et al. (1996) use FDH to evaluate the performance of university-affiliated credit unions and compare their performance with that of other credit unions. They find support for the hypothesis that university-affiliated credit unions, by virtue of the higher educational attainment of their membership, some of whom sit on the board of directors that oversees management, operate more efficiently than other credit unions. Frame and Coelli (2001) employ a stochastic cost frontier to investigate US corporate credit unions for the period 1992-1997. They find that 91% are cost efficient, with those credit unions investing a greater proportion of their assets in a centralised fund being most efficient. Glass and McKillop (2006), utilise a stochastic frontier approach to examine cost inefficiency under different environmental situations. The results suggest that: federal credit unions are more cost efficient than state credit unions and larger credit unions and multiple group credit unions are more cost efficient than their smaller, and single bond, counterparts. Wheelock and Wilson (2011) use a non-parametric local-linear estimator to estimate a cost relationship for credit unions and find evidence of increasing returns to scale over the period 1989-2006. They conclude that further deregulation which allows credit unions to expand their scale or scope of activities will lead to further increases in size and improvements in efficiency.

For Australia, Worthington (1998) and Esho (2001) utilise the parametric stochastic frontier approach while Brown et al. (1999) uses non-parametric data envelopment analysis (DEA). Worthington (1998) notes that large well capitalised credit unions with small branch networks are more efficient. Esho (2001) notes that there is little improvement in average efficiency over the period 1985 to 1993. Brown et al. (1999) find no evidence that the average credit union moved closer to the efficient frontier

For the UK, McKillop et al. (2002) use DEA to obtain radial and non-radial efficiency measures while McKillop et al. (2005) use a stochastic frontier analysis to evaluate the relative performance for the period 1991 to 2001. The results of both studies suggest that UK credit unions have considerable scope for efficiency gains. These studies also suggest that credit unions suffer from a considerable degree of scale inefficiency with in excess of 50 percent of scale inefficient credit unions subject to decreasing returns to scale. Glass et al. (2010) assess the efficiency of Irish credit unions using a two-stage approach. The analysis revealed that 93 percent of Irish credit unions operate at various levels of inefficiency, with this leaving seven percent of credit unions identified as best-practice. While best-practice and inefficient credit unions had many similar characteristics it was clear that those identified as best-practice had much lower levels of bad debt and tended to be designated as industrial/associational credit unions. A further insight to emerge from the analysis was that 68 percent of Irish credit unions do not face a specific extra opportunity cost of complying with bad debt guidelines as dictated by the regulatory authorities.

Overall, there is less consistency in the observed findings for frontier based studies relative to the earlier production function and ratio based studies. Efficiency is influenced by an extensive range of factors, and the observed findings depend upon both the methodological approach utilised and the geographical area investigated. This is unsurprising given that the regulatory environment and maturity of credit unions differs between countries. Finally, while a small number of studies find a positive impact of size on efficiency, the remaining (majority) find little evidence of an empirical relation.

3. Methodology

This study examines the evolution of efficiency for Irish credit unions. In order to do this, we employ a translog enhanced hyperbolic distance function model to examine the relative performance of credit unions. Section 3.1 describes the enhanced hyperbolic distance function and efficiency, Section 3.2 details the translog version of the function, while Section 3.3 demonstrates the manner in which the function can be estimated within a stochastic frontier framework.

3.1. The enhanced hyperbolic distance function and efficiency

Let us consider a financial institution productive process that transforms input vectors $x_i = (x_{1i},...,x_{Ki}) \in R_+^K$ into vectors of desirable outputs $y_i = (y_{1i},...,y_{Mi}) \in R_+^M$ and vectors of undesirable outputs $b_i = (b_{1i},...,b_{Ri}) \in R_+^R$, where $i = (1,...,N)$ is the set of observed financial institution producers. The production technology is given by

$$T = \{(x,y,b) : x \text{ can produce } (y,b)\}, \tag{1}$$

with this production possibility set assumed to be a compact set satisfying the axioms of production given in Färe and Primont (1995). Following Cuesta et al (2009), the production technology can also be represented by what they call an enhanced hyperbolic distance function $D_E(x,y,b)$. This represents the simultaneous maximum expansion of the desirable output vector and contractions of the undesirable output vector and input vector as defined by

$$D_E(x,y,b) = \inf\{\theta > 0 : (x\theta, y/\theta, b\theta) \in T\}. \tag{2}$$

As (2) requires simultaneous equiproportionate expansion in y and contractions in b and x, it yields a hyperbolic path to the production frontier.

When weak disposability of outputs and inputs is assumed, $D_E(x,y,b)$ fully characterizes the technology and has a range $0 < D_E(x,y,b) \leq 1$. The enhanced hyperbolic distance function (2) thus provides an efficiency measure. When the maximum equiproportionate expansion of y and reductions in b and x (required to place a given observation (cooperative bank) on the boundary of T) is $D_E(x,y,b) = 1$, the given financial institution is deemed to be an efficient producer located on the production frontier. Contrariwise, if $D_E(x,y,b) < 1$, the financial institution could improve its productive efficiency by expanding its production of y and contracting its production of b and usage of x - hence it is deemed to be an inefficient producer.

As elucidated in Cuesta et al (2009), which extends Cuesta and Zofio (2005) by incorporating undesirable outputs, the enhanced hyperbolic distance function (2) satisfies the following properties: (i) it is *almost homogeneous* (ii) it is *non-decreasing in desirable outputs,* (iii) it is *non-increasing in undesirable outputs* and (iv) it is *non-increasing in inputs*.

3.2. The translog specification of the enhanced hyperbolic distance function

Property (i) above is particularly relevant to the empirical analysis as it can be imposed on a translog specification enabling the use of a parametric translog hyperbolic distance function for (technical) efficiency estimation. The model also allows for time-varying inefficiency (as explained further below). This is important as it is unlikely that (technical) inefficiency remains constant over our 2002-2010 time period. Note also that, in the empirical analysis over 2002-2010, the model will also allow for technical change (or shifts in the production frontier) as well as for the foregoing change in technical inefficiency. As indicated in Cuesta et al (2009), the translog enhanced hyperbolic distance function (or translog EHDF for short) can be estimated via a stochastic frontier framework to yield (technical) efficiency estimates for each credit union.

3.3. Estimating the translog EHDF within a stochastic frontier framework

In the stochastic frontier approach, a producer's distance from the production frontier is viewed as the combined outcome of technical inefficiency and random shocks outside the producer's control. To incorporate these two components, a composed error term ε_{it} is employed. Within this additive error term, the effects of random shocks on producer i are captured by a two-sided, random-noise component v_{it}, while a one-sided error component u_{it} is used to capture inefficiency.

The translog EHDF to be estimated is given by

$$-\ln y_{Mit} = TL(x_{it}^{*}, y_{it}^{*}, b_{it}^{*}; \alpha, \beta, \gamma, \rho, \eta, \phi) + v_{it} - u_{it}, \tag{4}$$

where $-\ln y_{Mit}$ corresponds to the dependent variable and the $\varepsilon_{it} = v_{it} - u_{it}$ is the composed error term. The v_{it} are assumed to be independently and identically distributed as $N(0, \sigma_v^2)$, independently distributed of the u_{it}. The u_{it} are defined so as to embody the assumption that environmental conditions influence a credit union's technical inefficiency. Hence the technical inefficiency term is made an explicit function of a vector of producer-specific environmental variables z_{it}. This is done by employing the Battese and Coelli (1995) maximum likelihood method which specifies that the u_{it} are independently (but not identically) distributed as truncations (at zero) of a general normal distribution of form

$$\left|N(\mu_{it}, \sigma_u^2)\right| \quad \text{or} \quad \left|N(\sum_{j=1}^{J} \delta_j z_{jit} + e_{it},\ \sigma_u^2)\right| \tag{5}$$

where δ_j are parameters to be estimated and e_{it} is a random variable which is independently distributed as a truncation of a normal distribution $N(\mu_{it}, \sigma_\mu^2)$ such that $e_{it} \geq -\delta_j z_{it}$. This means that μ_{it} distributed as a non-negative truncations of a normal distribution $N(\mu_{it}, \sigma_\mu^2)$ in which $\mu_{it} = \delta_j z_{it}$ indicates that the expected value of u_{it} is influenced by different factors with a constant variance. In the empirical analysis, one of the elements of z_{it} is specified as a time trend to allow technical inefficiency to change with time.

The parameters of the model are estimated via maximum likelihood and, following Battese and Coelli (1988), the technical efficiency (TE_{it}) point estimators are obtained as $E[\exp(-u_{it}) \mid \varepsilon_{it}]$. In estimating the enhanced hyperbolic distance function model, the regressors $x^*_{kit} = x_{kit}y_{Mit}$, $y^*_{mit} = y_{mit} / y_{Mit}$ and $b^*_{rit} = b_{rit}y_{Mit}$ in equation (4) are considered to be exogenous.

4. Data description

The database upon which the analysis is based comes from a variety of sources. In each year the majority of the data (annual information on approximately 375 credit unions|) was provided by the Irish league of Credit Unions (ILCU). Data for credit unions affiliated to the Credit Union Development Association (CUDA), those that are independent of any trade body and those who had not filed returns to the ILCU were collected manually from the annual reports of the credit unions in question (25-30 credit unions per year). It should be noted that the data provided by member credit unions to the ILCU is unaudited. A nine year period is analysed from 2002 to 2010.

There are 404 credit unions registered in Ireland and this number has remained broadly stable over the course of the investigation period. Unfortunately a small number of credit unions failed to file returns in specific years and for others certain aspects of the data were either incomplete or inconsistent. In Table 1 we report summary statistics for the credit unions analysed in each of the years under consideration. It can be seen that between 2002 and 2009 our sample set consisted of a minimum of 374 (90.1%) in 2002 and a maximum of 399 (97.1%) in 2006. In 2010, the final year of the sample, we have only been able to obtain annual returns for 178 (44%) of credit unions primarily because the supervisory function provided by the ILCU has in large part now been made redundant by the more overt monitoring of credit unions by the Central Bank. This has led to a number of credit unions not filing returns with the ILCU. Unfortunately the Central Banks does not provide data on individual credit unions to independent researchers.

In the modeling of the productive process of credit unions there a number of ways in which inputs and outputs are specified – intermediation, production, value added, user-cost and asset approaches. The intermediation approach has tended to dominate empirical research (including the only other study on Irish credit unions, Glass et al. (2010)). Worthington (2010) suggests that the predominance of the intermediation approach is due to its adaptability which flows from the fact that categories of deposits, loans, financial investments and financial borrowings may be arbitrarily assigned to either inputs or outputs or excluded on the basis of *a priori* reasoning.

In this study the intermediation approach is utilised with a three input, three 'good' output and one 'bad' output process specified. The inputs are: (i) labour expenditure, x_1, (salaries, pension contributions, training and treasurer's honorarium), (ii) capital expenditure, x_2, (premises, equipment, depreciation, rent rates, light, heating, cleaning, repairs and renewals, equipment lease and maintenance expenditure) and (iii) fund expenses, x_3, (interest paid on deposits and dividends paid on members' shares). The 'good' outputs are: (i) members' funds, y_3, (members' shares and members' deposits), (ii) loans to members, y_1, and (iii) earning assets, y_2,(bank deposits, European Union (EU) government bonds, bank bonds and equity investments). The 'bad' output, b_1, is impaired assets which are impaired loans adjusted for investment losses. Mean and standard deviation values for the period 2002-2010 are presented for each of these variables in Table 1a.

The modeling process also provides insights into how certain producer-specific environmental variables influence credit union inefficiency. A number of variables proved important and summary statistics for these variables are detailed in Table 1b and 1c. The continuous variables in question are asset size; dividend ratio; return on assets (surplus/total assets); capital ratio and a liquidity ratio (see table 1c for details). Categorical variables are included to distinguish credit unions in terms of their common bond type, compliance with regulatory capital requirements and whether they have embraced web technology for product and service delivery. It should be noted that there is a relatively low level of web-based delivery of products and services. This can be traced to the failure in 2001 to introduce an integrated IT solution for Irish credit unions. This initiative cost €100m without any tangible end result. It then necessitated credit unions seeking IT solutions on an individual basis. However, such an approach is sub-optimal as even the largest credit unions do not have the financial resources to put in place systems which would enable them to compete effectively with, for example, the retail banks.

In the modeling of the productive process we also include a dummy variable to distinguish between credit unions with occupational/associational and community based common bonds. In an Irish context these two groups of credit unions are viewed as being subject to differences in their productive processes. Occupational credit unions draw their membership from a pre-designated employee group and by definition the membership is likely to be in either full- or part-time employment. Savings and loan repayments are invariably deducted straight from salary and in consequence these credit unions are subject to minimal bad debt problems. In contrast, community based credit unions draw their membership from a geographic area and this membership will be a mix of the employed, unemployed and retired. Linking savings and loan repayments directly to salary will not be an option for all members of community based credit unions. Furthermore, occupational credit unions in that they have a 'quasi-captive' membership will find it much easier to market and target products and services. This well-defined market could however also be viewed as an Achilles heel in that it implies that the membership mix of the credit union is undiversified and if the parent employer should face difficulties it will have a disproportionate effect on the credit union. From Table 1c we note that approximately 90% of credit unions have a community based common bond.

From the information presented in Table 1a an insight can be obtained into two of the primary challenges now facing Irish credit unions - a decline in the loan book (with an associated rise in investments) and a rise in bad debts. From Table 1a we can calculate that the average loan to asset ratio has declined from 57.21% in 2002 to 39.07% (2010) and that investments as a percentage of assets have increased from 39.51% in 2002 to 47.36% in (2010). The guidance from the World Council of Credit Unions (WOCCU) suggests that an appropriate value for the loan to asset ratio should be somewhere between 70 and 80 percent. This emphasises that credit unions in Ireland are significantly 'under lent'.

Under lending has been an ongoing problem for the Irish movement since the late 1990s and has two main causes. First the loan product portfolio on offer from Irish credit unions is quite restricted and second competition in the financial market has intensified during at least the early part of the estimation period. There is however evidence that the financial crisis has led to the exit of some financial institutions from the Irish market (HBOS and PostBank) and significant retrenchment by others thus reducing competitive pressures (see Hanley and Rae, 2010). This respite is likely to be short-lived as commitments have been made by the Irish Government to the EU Competition Authority to undertake a set of measures *"to restore competition in the Irish banking market by facilitating entry and expansion of competitors and enhancing the consumer protection in the financial sectors"*.[1]

From Table 1a we can also see that impaired assets have risen sharply since the start of the economic downturn. Between 2007 and 2008 impaired assets increased on average by 35% from €495,000 to €673,000, increasing by a further 35% between 2008 and 2009 and by an additional 33% between 2009 and 2010. These problems can be directly linked to the downturn in the Irish economy. In Ireland, personal consumer expenditure fell by 1.1% in 2008, 6.9% in 2009 and 0.8% in 2010 while the

[1] http://ec.europa.eu/eu_law/state_aids/comp-2009/n546-09.pdf

unemployment rate increased to 6.3% in 2008, 11.8% in 2009 and 13.6% in 2010, (IBEC, January 2012).

5. Empirical results

The empirical results for the estimated model are presented in Table 2.

5.1. Elasticities

The parameter estimates for the α_k (*input elasticities*) indicate the magnitude of the respective input elasticities at the sample mean. Table 2 shows that all α_k have the expected negative sign and are significantly different from zero. The negative signs found are expected as any increase in the amount of inputs used (ceteris paribus) would mean a greater distance to the frontier. The α_k values reveal that while the labour expenses (x_1) and capital expenses (x_2) elasticities are very similar in size (α_1 = -0.157 and α_2 = -0.121, respectively), the higher funds expenses (x_3) elasticity value (α_3 = -0.198) indicates the relatively more important role of this input in the credit union production process.

The estimated undesirable output parameter γ_1 (*bad output elasticity*) which is significantly different from zero, also has the expected negative sign in Table 2. When compared to the sizes of the input elasticity values, the impaired loans and investments elasticity value (γ_1 = -0.071) is lower indicating that, while still important, impaired loans and investments have relatively less importance in the distance function characterization.

The statistically significant β_m estimates (*good output elasticities*), recorded in Table 2, all have the expected positive sign. This indicates that any increase in the amount of good outputs produced (ceteris paribus) would mean a smaller distance to the frontier. From Table 2, it can be seen that the relative sizes of the output elasticities show (as expected) loans (y_1) to be considerably more important in the credit union production process than earning assets (y_2) – the respective elasticity values being. β_1=0.168 and β_2=0.048. The finding that the earning assets elasticity is extremely low is a result of some importance in that it emphasizes that a further increase in an already 'unhealthily' high level of investments would result in only a marginal reduction in the distance to the frontier.

5.2. Returns to scale

Returns to scale measures for distance functions can be obtained in terms of the input and output elasticities. From Table 2, it can be seen that the estimated value of the term is $[(-2\Sigma_k \alpha_k) - \gamma_1]$ = 1.0202, thus suggesting increasing returns to scale. Computation of the relevant standard error (0.0044) indicates that this finding of increasing returns to scale is significantly different from one (the constant returns to scale case) at the 5% level.

The finding of increasing returns to scale for Irish credit unions is consistent with what tends to be found for other credit union movements. Esho (2000), for Australian credit unions, found very pronounced increasing returns to scale. Murray and White (1983) and Kim (1986) both found 'slightly' increasing returns to scale for Canadian credit unions, while McKillop et al. (1995) and McKillop et al. (2002) found increasing and mainly non-decreasing returns to scale, respectively, for UK credit unions. Similar to the latter study, Sibbald and McAlevey (2002) found mainly non-decreasing returns to scale for credit unions in New Zealand, while both Glass and McKillop (2006) and Wheelock and Wilson (2011) found evidence of increasing returns to scale for US credit unions.

The finding of increasing returns to scale is also supportive of one of the policy recommendations emanating from the Irish Commission on Credit unions (2012) which advocates the establishment of a restructuring board to facilitate and incentivize credit union amalgamations *"to provide the opportunity* *to stronger credit unions to develop a more sophisticated – and ultimately more sustainable – business model and provide a mechanism to sort through the financial stresses in the sector in an orderly way".*

5.3Technical progress

Time dummies were included to capture neutral technical change. Table 2 records that six of the time dummies coefficients (ψ_t) are statistically different from zero. Four of these coefficients have a negative and significant sign, indicating technical progress or upward shifts in the production frontier while two have a positive and significant sign indicating technical regression or inward shifts in the frontier. It is noticeable that technical regression occurs in the period post 2007. Overall the values of these coefficients do suggest that aggregate technical regression of 2.62% was experienced over the 2002-2009 period (the coefficient estimate for 2010 is statistically insignificant so isn't considered in this calculation), thus giving an average annual rate of decline 0.33% over this period.

The technical regression of recent times may in part be linked to the uncertain and increasingly unstable environment that credit unions are now experiencing. Prior to 2008, cost to income ratios for credit unions trended around 47.0% since then they have steadily increased 62.2% (2008), 74.4% (2009) and 83.3% (2010) with much of this increase driven by higher levels of provisioning. In such a deteriorating market environment credit unions are understandably reluctant to invest in infrastructural and technological enhancements and without such continued investment, technology becomes uncompetitive and technical regression may occur.

In the modeling of the productive process we also include a dummy variable with coefficient ξ, to distinguish between credit unions with occupational and community common bonds arguing that these two groups are subject to differences in their productive processes. The coefficient

ξ is negative (-0.041) and significant at the 1% level indicating that more occupational rather than community credit unions raise credit union output. This reinforces the earlier observation that occupational credit unions, relative to community credit unions, have advantages in terms of a membership in full- or part-time employment and in the ease with which products and services can be marketed to members.

5.4. Technical efficiency scores

In proceeding to examine the technical efficiency scores, we first test the null hypothesis of no technical inefficiency. This test enabled us to reject the null hypothesis of no technical inefficiency effects in the Irish credit union production process. Since technical inefficiency does help to explain deviation from the production frontier, we can now examine how Irish credit unions could potentially improve their productive performance.

As the mean technical efficiency value for the estimated translog EHDF was 0.844 with a standard deviation of 0.137. The mean technical efficiency value suggests that the Irish credit unions sector could improve its productive performance by expanding its desirable outputs by 18.48% (1/0.844 = 1.1848), while simultaneously contracting its impaired loans and investments output and inputs by 16.6% (1 – 0.844 = 0.166). Note, in getting this empirical evaluation of productive performance, the translog EHDF model has the desirable property of crediting the credit unions for impaired loans and investments reduction as well as for desirable output expansion and input reduction. As Cuesta et al (2009) note, this enables a comprehensive approach to efficiency measurement which takes into account all outputs and input dimensions. This comment is particularly pertinent for Irish credit unions. Take as an example the manner in which the main trade association, the ILCU, oversees its member credit unions. On a quarterly basis credit unions are required to complete a report from which a range of compliance ratios are calculated. These ratios focus on all aspects of a credit union’s business model including cost and financial structure, output mix, asset quality, and growth objectives. Guidance in the form of norms for the respective ratios are stipulated by the ILCU with the implicit recognition that adherence to for example cost based norms and loan loss targets will necessarily have implications for output mix and output levels.

In Figure 1 we present the kernel density estimate of the distribution of the technical efficiency scores. The estimated density indicates that the efficiency scores are clustered around 0.90. There is a pronounced left tail to the distribution with credit union technical efficiency being as low as 0.23. Overall approximately 31 percent of the efficiency values (1042 observations) are less than the mean technical efficiency score of 0.84.

5.5. Factors influencing the technical efficiency of credit unions

In this section we discuss how the variables in the error term influence technical efficiency. Since the dependent variable is technical inefficiency, then a negative coefficient (the δs in Table 2) means that as the variable goes up this reduces inefficiency (or raises efficiency). A number of interesting findings emerge.

As the asset size of a credit union increases efficiency improves up to an optimal level (this can be seen from the significant quadratic relationship that exists, with the coefficient of the square of asset size being positive and statistically significant). This may be indicative of the fact that up to a certain size there are scale and scope economies to be achieved. To explore the relationship between size and efficiency further we analysed the distribution of efficiency scores relative to asset size for credit unions in five size bands (less than €20 million, €20million to less than €40million, €40 million to less than €60million, €60 million to less than €100 million and greater than €100 million). The key result to emerge was that credit unions with assets in excess of €100m are much more efficient on average than those in the other size categories.

Our analysis also highlighted that better capitalised credit unions are more efficient however set against that it was also the case that credit unions which held excessive levels of capital were found to be relatively inefficient. The distribution of the efficiency scores for credit unions that fell beneath regulatory capital guidelines over the period against those that met the capital requirements was also considered. The analysis demonstrated that those credit unions meeting capital requirements are on average more efficient that those that fail to meet the regulatory reserve guidelines. The Irish Commission on Credit unions (2012) found capital levels a problem for a number of credit unions. The Commission reported that there were 51 credit unions that as of December 2011 did not meet regulatory capital requirements. Furthermore the Prudential Capital Assessment Review undertaken by the Central Bank indicates that *"the financial position of a significant number of credit unions will deteriorate markedly between now* [March 2012] *and 2013*." Our analysis suggests that these credit unions are likely to have higher levels of technical inefficiency.

Occupational or associational credit unions are more efficient than their community based counterparts. The better performance of occupational/associational credit unions as earlier argued is influenced by the fact that the majority of their members are in salaried employment, whereas community credit unions may have a proportion of unemployed members. For certain occupational/associational credit unions there may also be some hidden 'in kind' advantages, for example many occupational/associational credit unions not only operate direct payroll deduction of loan repayments but also have a savings plan linked to salary.

Credit unions that pay a higher dividend to their members are more efficient but credit unions with higher liquidity levels are less efficient. This latter result is not intuitively obvious. It occurs because credit unions in Ireland are under lent and in consequence many credit unions hold an excessive part of their asset base in highly liquid assets which although low risk will also be low return. The regulatory required liquidity ratio for credit unions is currently set at 20% however the average liquidity ratio in 2010 was 47.36% (see Table 1b).

A dummy variable is included to account for whether a credit union has a website. We do not distinguish between websites which are solely information based and those that enable financial transactions to be performed. Our findings suggest that credit unions with a website are more efficient than those that do not have a website. This ‘customer facing’ technological change brings with it additional delivery channels for a credit union’s product offerings. Thus providing an increased flexibility to existing members coupled with lower per member processing costs.

Finally, we found deterioration in efficiency levels over the period 2002-2010 as earlier indicated this is to be expected given the significant deterioration in the Irish economy in recent years which has placed the business model of many credit unions under significant pressure. The Irish Commission on Credit unions (2012) highlights this when it states .. *“the adverse economic conditions have resulted in a decline in credit union performance and have made it difficult for credit unions to replenish reserves through retained earnings, ... the declining fortunes of the Irish economy have not only put an additional brake on credit union development but arguably have contributed to regression in some credit unions.”*

5.6. Substitutability and complementariness relations in production

Morrison-Paul et al (2000) have demonstrated how second-order cross terms can yield additional insights about interactions in the production process. For example, they show how α_{kl} reflects the extent of input substitutability or complementarity between inputs x_k and x_l. They note that an increase in x_l will both expand overall production and raise the marginal productivity of those inputs for which it is complementary more than those for which it is a substitute.

Table 3 shows that (in absolute terms) several of the values are not small in magnitude when compared to the corresponding first order (α_k) value. For example, Table 3 indicates that the labour expenses (x_1) and capital expenses (x_2) inputs are complementary in production, with an increase in one increasing the other's contribution to production. In contrast, Table 3 shows that relatively high substitutability exists between the funds expenses (x_3) input and the capital expenses (x_2) input and between the funds expenses input (x_3) and the labour expenses (x_1) input. The latter findings suggest, for example, that an increase in capital or labour expenses reduce the funds expenses input's contribution to production.

Similar cross terms, involving output and input interactions can be defined. In Table 3, a number of cross terms are not recorded (since the ρ_{11} and ρ_{22} parameter estimates are statistically insignificant in Table 2). The reported cross term values of -0.0137 and -0.0059 indicate that an increase in either the loans output (y_1) or the earning assets output (y_2) raises the funds expenses (x_3) input's contribution to production with, as expected, the impact of y_1 on the productivity of x_3 more pronounced.

Table 3 records the computed values of the cross terms between the respective inputs and the bad output. The recorded values are 0.0541, 0.0278 and -0.0199 which suggests that an increase in impaired assets b_1 reduces the labour (x_1) and capital expenses (x_2) contribution to production and raises the funds expenses (x_3) contribution to production. The latter result may follow from the fact that a rise in good loans (y_2) raises x_3's productivity and the complementariness found between good loans (y_2) and impaired loans and investments (b_1), as reported below, means that as y_2 rises b_1 also rises yielding a negative value, as above.

Measures reflecting the interaction between desirable outputs can also be defined and are reported in Table 3. The computed values are 0.0085 and 0.0133 and indicate substitutability between the good loans and investments outputs in production, that is a rise in good loans (y_1) output reduces the investments (y_2) output's contribution to production and vice versa. As earlier noted there has been a sustained fall in loans as a proportion of assets and a commensurate rise in investments as a proportion of assets over the period under investigation. The Irish Commission on Credit unions (2012) is suggesting less restrictive business lending for larger credit unions and that credit unions be permitted to provide additional products /services subject to meeting specific requirements set by Central Bank. Our analysis would suggest that such a development would enable credit unions to beneficially rebalance their portfolios away from investments and towards loans.

Following Grosskopf et al (1995), Cuesta et al (2009) indicate how the translog EHDF can yield information about the relative difficulty or ease of substitutability between a desirable output y_m and the undesirable output b_1 . In interpreting such values, Cuesta et al (2009) note that the more negative (greater in absolute terms) values signal a higher opportunity cost of y_m in terms of b_1 (relative complementariness) and vice versa. The estimated values are presented in Table 4. From Table 4, it can be seen that the highest relative complementariness (-32.4878) is found between good loans and impaired loans and investments as expected. Table 4 also shows that the absolute values are all well beyond unity, suggesting that regulatory guidance to encourage impaired loans and investments to be kept to a minimum would have a substantial impact on credit union output and performance. This is precisely what prudential guidance, as implemented by the Central Bank, strives to secure by it requiring that credit unions minimize impaired loans and investments.

6. Conclusions

This study examines the relative performance of Irish credit unions over the period 2002 to 2010. The approach used rewards credit unions for reducing undesirable outputs (impaired loans and investments) as well as for increasing desirable outputs and decreasing inputs. Four important findings emerge which are supportive of policy measures now being advocated to bring forward significant legislative change for Irish credit unions including a new Credit Union Act (Credit Union Bill published September 2012) and structural reform (Credit Union Restructuring Board appointed August 2012). These changes are in part structural benchmarks for the EU-IMF support now being provided to Ireland.

First, it was estimated that on average Irish credit unions could improve productive performance by expanding desirable outputs by 18.5% while simultaneously contracting impaired loans and investments and inputs by 16.6%, that Irish credit unions are subject to increasing returns to scale and that larger credit unions are more efficient than their smaller counterparts. The Irish Commission on Credit Unions (2012) had as one of its main policy recommendations the establishment of a Credit Union Restructuring Board to provide technical advice and capital funding to incentivise a major restructuring of the sector. This restructuring will involve the identification of anchor credit unions, those that are strongest within the sector, with weaker credit unions then merged into the anchor credit unions to create much larger entities. Our findings demonstrating significant technical efficiency differences, technical efficiency positively correlated with scale and a sector characterised by increasing returns to scale would suggest that the proposed restructuring will yield efficiency gains.

Second, our analysis found that larger credit unions that are better capitalised and pay a higher dividend to members are more efficient than their smaller, less capitalised, and lower dividend paying counterparts. This would suggest that the Credit Union Restructuring Board should build the restructuring process on credit unions which are large in terms of their asset base, are well capitalized and have continued to provide a good dividend to their members over our investigative period.

Third, we determined that there was a high degree of substitutability between loans and investments. A problem faced by Irish credit unions over the last decade is ongoing difficulties in the on-lending of funds and consequently accumulating an unhealthy level of investments. The Irish Commission on Credit Unions (2012) advocated that larger credit unions, that are capable of operating on a more sophisticated basis, should be allowed to offer a wider range of products and services and engage in a broader range of lending and investment activities. The Irish Credit Union Bill, published September 2012, provides for a more sophisticated and more permissive regulatory regime for larger credit unions. It details a three-tiered regulatory approach with 'tier three credit unions' (those with assets greater than €100m) having additional regulatory requirements but also enhanced product and service flexibility. Our empirical analysis supports such developments by suggesting that the availability of new loan offerings will act as an important substitute for investments, thus pushing credit unions towards a more appropriate balance between lending and investment activities.

Fourth, over the investigative period technical regression is observed driven in the main by the post 2007 period. This finding emphasizes the extent to which recent adverse economic conditions have resulted in a decline in credit union performance. Challenging times are expected to continue, IBEC

(2012) forecasts a decline in consumer expenditure and increases in unemployment in 2012 and 2013 while the Central Bank's Prudential Capital Assessment Review of credit unions anticipates a further deterioration in the financial position of a significant number of credit unions. This unpromising future for credit unions adds further support to the need for restructuring.

Table 1a

Descriptive statistics

Outputs	Members funds(000s)		Loans(000s)		Earning Assets(000s)		Impaired Assets(000s)	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
2002	16,897	21,638	11,176	14,969	7,870	11,038	239	381
2003	19,494	25,033	11,979	16,059	9,922	13,850	303	453
2004	22,376	28,809	12,966	17,284	12,094	16,821	359	546
2005	24,946	31,060	13,579	16,603	14,374	20,032	404	609
2006	25,965	32,165	13,745	16,717	15,413	21,354	441	682
2007	24,332	31,084	13,468	18,071	14,203	19,619	495	779
2008	24,458	30,839	14,319	18,842	13,509	18,986	673	980
2009	25,197	31,725	14,040	18,764	14,986	19,992	914	1,283
2010	23,241	21,941	11,951	12,079	15,023	15,709	1,218	1,397
Total	23,005	29,049	13,101	16,982	12,944	18,085	519	852
Inputs	Labour expenses(000s)		Capital expense(000s)		Funds expenses(000s)		Mean Ratio	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Loan to Assets	Investments to Assets
2002	157	172	47	46	380	665	57.21%	39.51%
2003	174	195	51	52	417	733	52.97%	42.33%
2004	206	244	55	55	348	506	49.18%	43.55%
2005	216	233	61	65	398	605	46.07%	44.35%
2006	228	248	65	68	429	707	42.66%	43.38%
2007	233	249	64	66	407	752	41.44%	40.57%
2008	257	285	70	70	508	880	43.61%	37.69%
2009	279	307	74	77	409	777	43.05%	43.37%
2010	261	250	70	64	256	407	39.07%	47.36%
Total	221	248	61	64	403	699	46.54%	42.16%

Note: All monetary variables are in euros and in 2002 real terms, having been deflated by the Consumer Price Index.

Table 1b
Descriptive statistics

Environmental variables	Total Assets(000s)		Dividend ratio		Return on Assets		Capital Ratio		Pearl Liquidity ratio	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
2002	19,549	25,322	2.10%	1.06%	0.80%	1.49%	9.97%	2.97%	39.51%	14.30%
2003	22,872	29,645	2.00%	1.03%	0.75%	1.59%	10.23%	3.01%	42.33%	13.75%
2004	26,872	34,737	1.72%	1.79%	0.75%	1.53%	10.28%	3.48%	43.55%	13.19%
2005	30,769	38,237	1.53%	0.87%	0.73%	1.52%	10.41%	2.99%	44.35%	12.29%
2006	33,681	41,565	1.51%	0.80%	2.07%	1.93%	12.48%	3.15%	43.38%	11.61%
2007	33,469	42,683	1.49%	0.93%	2.40%	2.06%	13.83%	3.15%	40.57%	11.76%
2008	33,942	42,659	1.81%	0.98%	2.71%	2.31%	13.63%	3.20%	37.69%	12.26%
2009	33,319	41,629	1.40%	0.95%	2.36%	2.39%	12.74%	3.24%	43.37%	12.25%
2010	30,959	29,301	0.87%	0.73%	1.42%	1.73%	12.45%	2.94%	47.36%	11.75%
Total	29,444	37,509	1.65%	1.11%	1.56%	2.04%	11.74%	3.48%	42.16%	12.87%

Table 1c
Categorical variables

	Common Bond Type			Regulatory reserve requirement			Internet Technology Adoption		
	community	occupational	Total	Under Capitalisted	Appropriately Capitalised	Total	No website	Live website	Total
2002	343	31	374	222	152	374	308	66	374
2003	353	31	384	183	201	384	305	79	384
2004	357	32	389	177	212	389	300	89	389
2005	351	36	387	164	223	387	286	101	387
2006	364	35	399	139	260	399	291	108	399
2007	353	32	385	82	303	385	270	115	385
2008	348	35	383	65	318	383	203	180	383
2009	351	31	382	204	178	382	203	179	382
2010	163	15	178	82	96	178	102	76	178
Total	2983	278	3261	1318	1943	3261	2268	993	3261

✞Capital Ratio >8% in period 2002-2008 or >10% post 2008. *Capital ratio is below the regulatory reserve requirement.

Table 2
Parameter estimates for the translog enhanced hyperbolic distance function

Parameter	Estimate	Standard error	Parameter	Estimate	Standard error
α_0	0.500***	0.010	ϕ_{11}	0.026**	0.012
α_1	-0.157***	0.005	ϕ_{21}	0.041***	0.009
α_2	-0.121***	0.009	ξ	-0.041***	0.012
α_3	-0.198***	0.003	ψ_{03}	-0.001	0.006
α_{11}	-0.051***	0.003	ψ_{04}	-0.020***	0.008
α_{12}	0.009***	0.003	ψ_{05}	-0.032***	0.008
α_{13}	0.014***	0.001	ψ_{06}	-0.044***	0.008
α_{22}	-0.031***	0.005	ψ_{07}	-0.024***	0.009
α_{23}	0.013***	0.001	ψ_{08}	0.0124	0.009
α_{33}	-0.046***	0.001	ψ_{09}	0.0262***	0.010
β_1	0.168***	0.019	ψ_{10}	0.006	0.014
β_2	0.048***	0.017	δ_0	1.921	1.588
β_{11}	0.177***	0.036	δ_1	0.032***	0.004
β_{12}	0.034**	0.017	δ_2	-2.782**	1.184
β_{22}	0.048***	0.018	δ_3	0.321	0.328
γ_1	-0.071***	0.003	δ_4	-0.105***	0.043
γ_{11}	-0.043***	0.004	δ_5	-0.506***	0.183
ρ_{11}	-0.015	0.015	δ_6	0.309*	0.181
ρ_{12}	-0.044***	0.017	δ_7	0.406***	0.070
ρ_{13}	0.018***	0.005	δ_8	-0.179***	0.073
ρ_{21}	-0.044***	0.011	δ_9	0.0525**	0.026
ρ_{22}	-0.016*	0.010	δ_{10}	-0.291***	0.026
ρ_{23}	0.014***	0.004	δ_{11}	-0.029*	0.015
η_{11}	0.027***	0.003	σ^2	0.037***	0.002
η_{12}	0.014***	0.003	γ	0.9118***	0.067
η_{13}	0.010***	0.001	$Ln\ L$	2624.89	
	$\overline{TE}_{it}$	0.844	$Standard\ Deviation_{TE_{it}}$	0.014	

Note: * 10% significance level ** 5% significance level ***1% significance level.
The $\delta's$ (j = 1, …, 9) are the coefficients of the z variables influencing technical inefficiency, as given in (21), with δ_1 relating to a time trend; δ_2 to dividend ratio;δ_3 to return on assets; $\delta_4$to regulatory reserve requirements dummy (appropriately capitalised 1, undercapitalised 0); δ_5 to capital ratio; δ_6 to interaction term between capital ratio and regulatory reserve requirement dummy; δ_7 to Pearl liquidity ratio; δ_8 to log of total assets; δ_9 to square of the log of total assets; δ_{10} to common bond type dummy (occupational 1, community 0) and $\delta_{11}$to internet technology adoption dummy (live website 1, otherwise 0). Also, $\sigma^2 = \sigma_v^2 + \sigma_u^2$; $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$; and $\overline{TE}_{it}$ is the mean technical efficiency score.

Table 3
Elasticities

First order components				
Loans	Other Earning Assets	Labour	Capital	Funds
0.1797	0.0307	-0.1586	-0.1205	-0.1951
Second order cross components				
		Labour	Capital	Funds
Labour		0.1138	-0.0165	0.0333
Capital		-0.0169	0.0561	0.0319
Funds		0.024	0.0208	-0.1143
Impaired Loans & Investments		0.0541	0.0278	-0.0199
Loans			-0.0093	-0.0137
Other Earning Assets		0.0176		-0.0059
		Loans	Other Earning Assets	
Impaired Loans & Investments		-0.0069	-0.0159	
Other Earning Assets		0.0085		
Loans			0.0133	

Note: From Table 2, the bad output elasticity at the sample mean is γ_1 = -0.071. The gaps in the above table arise when the relevant parameter estimates are statistically insignificant, so that the corresponding interactive measures cannot be computed.

Table 4
Good (y_m) and bad (b_1) output substitutability

	Loans	Other Earning Assets
Impaired Loans & Investments	-32.4878	-27.7925

Note: The above values are computed by observation.

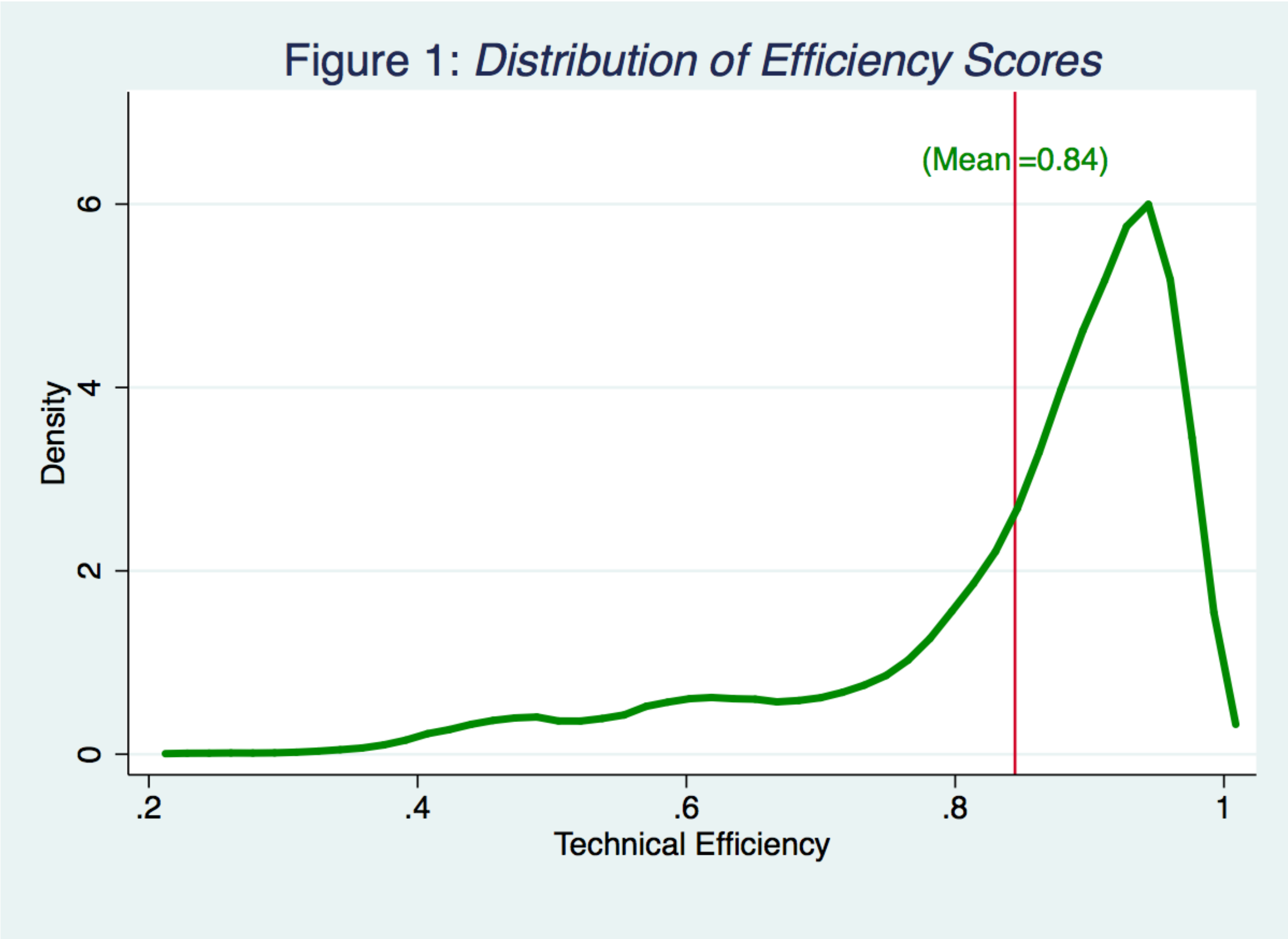
Figure 1: Distribution of Efficiency Scores
(Mean =0.84)
Density
0
2
4
6
.2
.4
.6
.8
1
Technical Efficiency

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